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THE NORTH POLE
THE GREAT ICE AGE
AND THE DELUGE

WITH AN

APPENDIX ON THE DIFFERING MAGNETIC PHENOMENA OF THE SOUTH

BY

W. B. GALLOWAY, M.A.

"*Out of whose womb came the ice?*"—JOB

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THE NORTH POLE, THE GREAT ICE AGE, AND THE DELUGE

SECTION I.

THE GREAT ICE-AGE continues to supply ever fresh material to the genius of modern geologists, and treasures of intellectual speculation are still being added to the rich accumulations of the last fifty or sixty years.

> Crescunt divitiæ, tamen
> Nescio quid curtae semper abest rei.

But, all other suggested causes of the supposed glacial Epoch having failed to give satisfaction,[1] "another possible cause" of it has been propounded, in a paper read before the Victoria Institute, by Professor Edward Hull, LL.D., F.R.S., F.G.S., which is published in the Journal of that Institute in the last year (1899)[2], and has been followed up by him in continuance in another paper, in February of the present year. Dr. Hull proceeds on the same general idea with some previous speculations of Mr. Warren Upham, a member of the Geological Survey of the United States, in supposing that the mysterious world-wide freezing had been attributable to some former great elevation of land in the Northern region such as to produce extreme and widely extended cold[1]: but Dr. Hull endeavours to connect that conjectural cause with deductions from soundings taken in the Atlantic by the British and the American navies, and partly also by private enterprise.

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[1] Such as the astronomical theory of Dr. Croll favoured by Sir C. Lyell, and also by Professor Geikie. "*Great Ice Age,*" Chapters ix. and x., and Journal of the Victoria Institute, vol. xxvi. page 221.

[2] Vol. xxxi. No. 123, p. 141.

He informs us that a submerged terrace has been discovered, stretching out under the Atlantic from the eastern coast of America to the hundred fathom line, and there terminating in an escarpment going down to an average depth of 450 to 500 fathoms (2700 to 3000 feet), where another terrace is met with, stretching out to a greater or less distance under the Atlantic, and which is often so steep that the two contours approach very close together; and that from the second terrace there is a sudden descent to the bottom, at the abysmal depth of 10,000 to 12,000 or 13,000 feet; and that in the Gulf of Mexico the valley or "cañon," in continuation of the bed of the Mississippi, and through which he assumes that it had once flowed, is traceable extending under the Gulf to a depth of 10,000 feet. That these submarine terraces being continuous throughout so great an extent of coast line, and with levels generally so uniform, exhibit, at these depths, marks of the present American rivers, like the Mississippi under the Gulf, stretching out also under the Atlantic from 200 to 300 miles; from which it is inferred that the Eastern coast of America was at one time 600 feet higher above the sea-level, or even from 2700 to 3000 feet higher than now, nay, beyond that from 10,000 to 12,000 feet.

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[1] See Mr. Warren Upham's paper in the Journal of the Victoria Institute, vol. xxix. p. 201, with discussion thereon.

It may be well to note here a neglected partial qualification by the late pre-eminent Baron Humbolt, who writes as follows. "Among the causes which tend to lower the mean annual temperature, I include the following:—Elevation above the level of the sea, *when not forming part of an extended plain,*" &c. In the present case it is a whole extended continent. "*Cosmos*" vol. i. p. 3.6, Bohn's Edit.

II. It will be observed that, as the evidence is drawn from the tracing of supposed river channels at those depths, it is an elevation of the *continent*, not of a mere coast line, which is postulated; since the river Mississippi flows through the very centre of the continent, and receives the affluence of the Missouri, the Red River, the Ohio, the Arkansas, and their tributaries. But the possibility of tracing with any certainty river-channels at a depth of 10,000 feet under the ocean may be questionable. It is obvious that even if the prolonged continuance of a valley or rocky cleft should be traced at that depth, there is no proof that the river, which may have taken advantage of its hollow in an upper portion, did not discharge its waters into the sea long before it reached those depths of the continuous cleft or cañon. The Atlantic Ocean doubtless has such depths; but was there then no Atlantic Ocean for the rivers to flow into, or for the land to sink into? Twelve thousand feet would imply an elevation of the very bottom, "the abysmal floor," of the Atlantic, as well as of the whole continent of North America; and Dr. Hull goes so far as to suppose that the Gulf of

Mexico did not then exist, but formed an Antillæan Continent, so that there was no longer any "gulf-stream" to mitigate the cold in the British Islands. And, of course, if the floor of the Atlantic was upheaved, there could be none. We do not profess to see a way through these inconsistencies, the Antillæan Continent having done away with the gulf and river's outflow: and Dr. Hull himself only masks the difficulty by quoting the remark that they "open new problems in dynamic geology." That *phrase* has certainly the ring of science, if only it conveyed any intelligible solution of the difficulty. The Mississippi, the St. Lawrence, and all the southward and eastward-flowing rivers of North America would have no ocean in which to deposit their burden of waters; or if the ocean were upheaved as well as its floor, what would become of the elevation above the sea-level? Of course the ocean is not meant to be upheaved upon its floor, whatever else is to be done with it.

No doubt there might be a question of dynamics. Has it been calculated how many hundred millions of tons, say rather of cubic miles, of solid rocks, each at least twice or thrice the weight of an equal bulk of water, are to be estimated in the vast continent of North America; and what applied force will be necessary all underneath, to upheave the whole continuous mass in its length and breadth twelve thousand feet aloft into the air? The illustrious Archimedes is reported to have said that, if he had a long enough lever, and a proper fulcrum to rest it on, he could move the world. But here neither lever nor fulcrum is provided, nor any platform, or screw, or apparatus whatever, nor any effort of force and will, nor any parallel since the days of the fabled giants, for uplifting on high the great continent of America, with the Mississippi and other rivers running down his broad back.

> Hunc armat glacialis ATHOS. Hoc OSSA movente
> Tollitur. Hic RHODOPEN HEBRI cum fonte revellit
> Et socias truncavit aquas, summâque levatus
> Rupe Giganteos humeros irrotat ENIPEUS.[1]

But all those mountains put together, which the giants upheaved, were a mere trifle to this; and the Enipeus was but as a dewdrop to the Mississippi. And all this merely to account for how the intense cold was to be got, sufficient to freeze up the world; all called out in that new internecine combat of giant glacial theorists, whose whole speculation is only a conjectural substitute for the UNIVERSAL DELUGE of scripture and of Christian faith, and of the still lingering vestiges of its memory among all nations. No doubt the Almighty power of God was sufficient for Dr. Hull, but we have no right to presume upon it to back up philosophical speculations. If it be thought that the ocean soundings prove the existence of a former coast line on the east of America relatively higher than the present, the explanation must be sought only by reasonable deduction from known facts of nature, and in accordance with its laws. The Most High "hath ordered all things by measure and number and weight." He hath "weighed the mountains in scales, and the hills in a balance." And this not only in regard to the heaviest things, but also to the lightest. "He hath made a weight for the winds, and He weigheth the waters by measure"; and He had told us this long before Torricelli obtained celebrity by practically applying it. But it is obvious that what the suboceanic terraces would prove is distinctly a relative sinking, not an actual elevation of the land there. At the hundred fathom line it is stated that the upper terrace breaks off with a precipitous descent to the lower terrace. The marks of the rivers, therefore, break off there, but are alleged to be found again continued on the lower terrace. Does this mean that, just at the hundred fathom line, all the rivers on the east of North America took a leap over the precipice to the depth of 450 or 500 fathoms (2700 or 3000 feet), and immediately found their continuous channels at that lower depth, and went on till they came to another break, where they took another leap, this time into abysmal space, or to the "abysmal floor of the Atlantic," perhaps then dry? These leaps seem to add to the doubt of the continued traceability of the rivers.

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[1] Claudian, *Gigantomachia*.

But to pass that over; and, assuming that the terraces under the Atlantic are *bonâ fide* sunk terraces, once dry land, does it prove more than that they have sunk? Some explanation may be asked and expected of their sinking, and we confidently hope that it may be satisfactorily given, though it may not be on the see-saw principle of alternate ups and downs; or, as Dr. Hull expresses it "periods of emergence and depression, interrupted by pauses"; which are meant to be in correspondence with their supposed alternations of long periods of world-wide glaciation, and of temperate or semi-tropical heat. We decline to admit that there is any evidence of the American coast or continent having been *upheaved* or *uplifted;* but if it should be shown to have *sunk* relatively to the former sea level, that is another matter, and is all that is in proof.

III. The Glacial Theory, so called, is quite recent, having been unheard of during a third part of the nineteenth century, and is really only a conjectural invention in substitution for the universal Deluge. And there is now a great division in the camp of its adherents. Formerly the larger part of them favoured Croll, who ascribed it to an astronomical cause, and calculated it as having been at its height two hundred and forty thousand years ago; and to have abated at about eighty thousand years ago; but the disgorging of an entire Mammoth from the ice within the last generation, caused some to reject that astronomical cause and its vast compass of time. And there has since sprung up this discovery or invention of a new cause, by men who still unwaveringly adhere to the grand theory, of enormous glaciers having covered all Europe and North America to a depth varying from 2500 to 8000 feet in thickness! Professor James Geikie, of the University of Glasgow, a geologist of the highest repute, and author of "The Great Ice Age," has declared himself a decided antagonist to the acceptance of this new proposed cause; and an able paper, in opposition to this Earth-Movement Cause, was contributed by him, and read at the Victoria Institute on the 11th of April, 1892. It is published in the xxvith volume of the Journal of that Institute, from page 221 onwards, together with the discussion thereon. "Having carefully studied," wrote Dr. Geikie at that time, "all that has been advanced of late years in support of the hypothesis in question, I find myself more than ever constrained to oppose it not only because it is grounded on no basis of fact, but because it utterly fails to explain the conditions that obtained in Pleistocene and post-glacial times." The same we confidently affirm of the whole hypothesis of world-wide glaciation. And Dr. Geikie, in his reply to the discussion on his paper, feeling himself challenged by Dr. Hull to present him with some other explanation of the cause, only replied "that the critic who essays to condemn a work of fiction, is, fortunately for himself, not expected to produce another in its place." This is tantamount to a confession that he can assign no cause for the glacial epoch; and it will be ultimately found to have no base, and to possess no possible advantage, unless it be simply to set aside Holy Scripture, and subvert the idea of its faithful truth, and its Divine inspiration and authority. For the scriptural record of the Deluge cannot be reconciled with a local and limited overflow of water, as some have inconsiderately pretended. What local flood could be imagined to have covered the mountain tops of Armenia, and to have lasted nine months at that height?[1] St. Peter speaks of it as having affected not only the earth, but the *heavens* also. And the patriarch Job, in his earnest vindication of his own innocence, is called to account by the Almighty for not having been equally mindful of the Lord's honour and glory." "The LORD JEHÓVAH answered Job out of the whirlwind, and said, Who is this that darkeneth counsel by words without knowledge? Gird up now thy loins like a man; for I will demand of thee and answer thou me."[1] The Lord's first demand is concerning the CREATION. "Where wast thou when I laid the foundations of the earth? Declare if thou hast understanding—when the morning stars sang together and all the sons of God shouted for joy?" Here is no allusion certainly to the shivering and cheerless gloom of the three thousand or from that to seven or eight thousand foot thickness of solid ice, covering the whole best continents of the earth to that depth for ages and ages; amid which man as a naked savage has been often delineated combating with starving lions and ravenous polar bears armed only with fossil flints. The LORD's next demand is in regard to the DELUGE. "Or who shut up the sea with doors, *when it brake forth as if it had issued out of the womb*, when I made the cloud the garment thereof, and thick darkness a swaddling band for it, and brake up for it my decreed place, and set bars and doors, and said, Hitherto shalt thou come but no further, and here shall thy proud waves be stayed? Hast thou commanded the morning since thy days, and caused the day-spring to know his place, that it might take hold of the wings (or *sides*) of the earth, that the wicked might be shaken out of it?" The Deluge is here placed directly in connection with a change of the place of *sunrise*, so that it took hold of places considerably on the two sides of the orient, rising in summer much to the north, in winter much to the south of the due east; and this in order "that the wicked might be shaken out of the earth," which was the declared purpose of the Universal Deluge, and was effected by it. But who knows not that the change of the place of sunrise could only be owing to a change of the earth's axis to an angular position relatively to the earth's orbit? The Scripture, therefore, here plainly associates the Deluge with a change of the earth's axis, which was its physical cause, and was the instrument by which the Deluge was produced, and the clearing of the earth from the wicked race of mankind was effected, with the single reservation of the family of Noah. This is entirely in accordance with the words of St. Peter that the whole visible heavens were changed at the Deluge, as well as the earth. Not a star, not the sun, much less the moon, or the planets, were to be found in their old places, or followed their old courses. This was the necessary effect of the change of the earth's axis.

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[1] Gen. viii. 5.

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[1] Job xxxviii.

IV. But this is Scripture: you do not expect that men of science are to believe it! Yes; they are at least not entitled to tamper with it, and treat it as fable, though it is not their special field of inquiry; and they may the more willingly believe it when it is confirmed by the faithful testimony of ancient astronomy. Anaxagoras, one of the best informed of the ancient Greek philosophers, who was the tutor of Socrates, and may have shared with him in popular misrepresentation by his satirist, and who was in his twentieth year when Xerxes crossed the Hellespont (B.C. 479), has preserved to us the following astronomical statement from remoter antiquity, "That the stars were at the first seen as if carried round within a vast dome in such a manner that the constant apparent revolution of the sphere was vertical to the earth, and that the inclination which it now has was received afterwards."[1] This, of course, is an express attestation of a change of the earth's axis of rotation, and that it took place while man was upon the earth, and under man's observation. But all these things are as nothing to those persons who have been long frozen to the glacial theory. Yet Lyell himself calls our attention to a geological fact, which itself necessarily implies a change of axis; or, which is the same thing, indicates that the earth's equator and the parallels of the earth's rotation in the various latitudes lay formerly very differently, and at an angle to the present. For he tells us[2] that "if we turn to the Upper Miocene formations of the West Indies, those for example of Antigua, San Domingo, and of Jamaica, we discover in them species of corals similar to those found in beds of the same age at Vienna, Bordeaux, and Turin, and some of which, as Dr. Duncan has shown, have a near affinity to species now living in the South Sea, Indian Ocean, and Red Sea. They lead irresistibly to the opinion that there was much greater analogy in those ages than there is now between the temperature of the West Indies, in lat. 18°, and that of Europe in lat. 48°." Now, if any one will stretch a thread, or lay the moveable quadrant upon the globe from Vienna to Jamaica, he will see at once that this demonstrates an angular change of the parallel of latitude, and consequently of the equator, and shews somewhat approximately its general direction.

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[1] Τὰδ' ἄστρα κατ' ἀρχὰς μὲν δολοειδῶς ἐνεχθῆναι, ὥστε κατὰ κορυφὴν τῆς γῆς τὸν ἀεὶ φαινόμενον εἶναι πόλον, ὕστερον δὲ τὴν ἔγκλισιν λαβεῖν. Diog. Laert. de vitis dogm. et apophth. claror. philosoph., lib. ii. 8, 9. Edit. 4to Amst. 1608, p. 84.

[2] Principles of Geology, vol. i. p. 201, 10th Edit. 1867.

V. The change of the earth's axis is thus a subject not irrelevant to our inquiry, and we shall have occasion to speak of it in its relation to one or two points preparatory to our remarks on the present inquiry. It is worthy of notice that, while the satellites of Jupiter and Saturn have their orbits approximately in the plane of the equators of their primary planets, which seems their first natural position on Laplace's theory of their having been originally embraced within an uncondensed state of their primaries; yet the moon, on the contrary, is at a divergence of 18½° from the plane of the earth's equator; for the moon's orbit is inclined only 5° 9′ to the plane of the earth's orbit, to which the earth's equator is inclined 23½°; the difference being roughly, about 18½°, and formerly more. And that is consistent with the *earth's* axis of rotation having been shifted about eighteen and a half degrees; not the moon's orbit, for that keeps nearer to the plane of the earth's orbit round the sun.

The same is indicated by the phenomena of terrestrial magnetism; for the Magnetic North Pole is about that distance from the earth's geographical North Pole, round which it is now well known to be slowly circling in the course of a series of centuries. From the valuable series of observations made by Captain Parry during the British Arctic voyages of discovery, Professor Hansteen calculated, that in 1819 the principal North magnetic pole must have been in North latitude 71°27′. This is in closely approximate agreement with the distance from the geographical North Pole we have assigned to it, namely 18½°, differing only 3′. Sir James Ross, on the 1st of June, 1831, found a place where the Dipping Needle stood at 89°59′ (only one minute of a degree from the perpendicular), in north latitude 70°5′17″, a difference of over a degree; but which may be owing to special magnetic circumstances affecting that portion of North America, as appears from an extensive collection and comparison of observations by Sir Edward Sabine.[1]

VI. Now this remarkable fact, of the secular revolution of the North Magnetic Pole round the North Pole of the earth, is in striking parallel to the revolution of the Earth's pole round the pole of the Ecliptic, in a far greater period of time; which, by the rate of the precession of the equinoxes, it is shewn to accomplish in 25,868 years. Both of these slow motions are in the *contrary* direction to the course of the earth in its orbit, and also to the direction of the diurnal rotation, and to the course of the moon; being both of them from east to west. Both have also the same *cause*, namely the obliquity of their respective equators; for it is well known that the magnetic equator is oblique to the plane of the earth's equator, as well as that the latter is at an angle of about 23½° to the plane of the ecliptic. These are undisputed facts: but the latter is more satisfactorily explained on Halley's theory, which shall be briefly stated. Perhaps some of those who have been hitherto incredulous, may not think it unworthy of them to give it a fairer thought, admonished as they may be, by the emphatic and confident words of such a man as Halley, that "*Thus, and not otherwise, may we explain the changes of the variation of the magnetic needle.*"

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[1] See the writer's "Science and Geology in relation to the Deluge," page 67.

From that variation and other facts of terrestrial magnetism an eminent nautical mathematician, Mr. Bond, to whom was entrusted in his day the care and correction and reissuing of the treatises of navigation, about or soon after the year 1650, was led to the conclusion, that there was a nucleus of the earth in its interior, revolving with an axis inclined to that of the earth.[1] In that conclusion he was followed as far as regards the existence of the separately revolving nucleus, by the celebrated astronomer Dr. Edmund Halley; but at first with the difference that he rejected the supposition of an angular inclination of its axis to that of the earth, and supposed the rotation to be about the same axis, and only at a different and slower rate of movement.[2] But, after longer observation and reflection, Halley came to see that Bond had been right in his assumption that the position of the axis of the nucleus must be angular; and he further came to the conclusion that the respective poles of the rotation of the earth and its nucleus were themselves the two magnets; thus doing away with the previous cumbersome idea that the nucleus had only been carrying round a big mass of loadstone, and the earth another. This agreement of opinion, and at last of conviction, may be read in his articles in the Philosophical Transactions for 1689, 1698, 1716 (vol. xxix. pp. 406—428), and for the year 1694 not *printed* at the time, but duly read before the Royal Society, and then reserved; and eventually, after thirty years' mature consideration, published in the Philosophical Transactions, vol. xxxiii. for 1724; in which paper he further ascribed the UNIVERSAL DELUGE to the change of the earth's axis as its probable physical cause. We have seen that in Holy Scripture, but probably quite unobserved by Halley, the Universal Deluge is placed in close connection with a change of the places of sunrise, and therefore with a change of the earth's axis. Halley's conclusion rested simply upon scientific grounds. He was still at that time secretary of the Royal Society; and his friend Sir Isaac Newton was still in life, in deference to whom, probably, he had formerly reserved it from being printed: and therefore it carries with it his full sanction after thirty years' additional experience and observation, with his maturest thought in the science of Terrestrial Magnetism, of which he was practically the founder. "Thus and not otherwise," writes this illustrious man of science "may we explain the changes of the variation of the Magnetic Needle."

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[1] On Halley's Statement. Phil. Trans. for 1668, and for 1683.

[2] Halley's Paper in the Phil. Trans. for 1683.

In opposition, what can be said? That we have the advantage of a more advanced state of science, and of more than two hundred years additional experience beyond Halley? Yes: and what is the result of that experience? For more than two hundred years, in various nations, the highest scientific powers of many minds have been applied to find some different solution; and have failed! The late Astronomer Royal, Sir George Biddell Airy, concludes his treatise on Magnetism in these words, "On the whole we must express our opinion that the general cause of the earth's magnetism still remains one of the mysteries of cosmical physics." This was in 1870. And a still more distinguished contemporary of Airy in that department, the late General Sir Edward Sabine, expressed from the presidential chair of the Royal Society in 1864,[1] his opinion, that Halley's Terrella had not received the attention it deserved. This is the confessed result of our additional two hundred years' advancement and experience,—the simple confirmation of Halley's emphatic words, "Thus, and *not otherwise.*"

VII. We may further briefly point out that, on this theory, *the cause of the secular revolution of the magnetic pole, round the pole of the earth*, is strictly parallel to that which Sir Isaac Newton discovered to be the cause of the slow recession of the equinoctial points, and consequently of *the secular revolution of the pole of the earth round the pole of the ecliptic;* namely the obliquity of the earth's protuberant equator in reference to the plane of the earth's orbit, and to the orbit also of the moon; according as that oblique protuberance is acted on by the attraction of the sun and moon in the earth's daily rotation.[2] Now in the case of the Magnetic pole's secular revolution round the pole of the earth, a similar *obliquity of the magnetic equator* to the plane of the *earth's equator* exists. There is also a proportional equatorial protuberance in the nucleus, now placed obliquely to the equator of the earth; and it must be similarly acted on by the closer attraction of the enclosing earth's oblate equatorial belt. I leave this brief suggestion without further remark though it may seem at first obscure.

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[1] Phil. Trans, of that year, p. 242.

[2] The general reader will find the simplest statement of it in an excellent little book entitled "Astronomy without Mathematics," by E. B. Denison, L.L.D., Q.C. (afterwards Lord Grimthorpe), which is published by the Society for Promoting Christian Knowledge.

VIII. But obviously, upon Dr. Halley's theory, the separate rotation of a central nucleus in the interior of the globe requires either a fluid stratum to move in, or else an empty hollow spheroidal space. The latter is not easily conceivable, though once suggested by Professor Robison, who held the Chair of Natural Philosophy in the University of Edinburgh, and was also Secretary of the Royal Society, Edinburgh, about 1799 (See Encyc. Brit. Third Edit.; Supplem. vol. ii., Article "*Magnetism*," p. 142). Dr. Robison says, "The hypothesis of Dr. Halley that the globe which we inhabit is hollow and includes a magnetic nucleus, moving round another axis, is not inconsistent with any natural law if he did not suppose the interval filled up with some fluid. The action of the nucleus and shell on the intervening fluid would gradually bring the two to one common motion of rotation, as may be inferred from the reasonings employed by Newton in his remarks on the "Cartesian Vortices."

In regard to this it may be remarked, (1st), That the immense weight and impetus of the two rotating bodies of the earth and the nucleus would necessarily make the tendency towards their returning to one rotation much slower. (2nd), That the effect referred to has actually been slowly and gradually taking place, and, as far as we can judge, ever since the Deluge,—the obliquity of the ecliptic being annually diminished by a minute quantity; and this is allowed for by Astronomers in the calculation of remote eclipses. The operation of this cause may be perhaps a truer explanation of the principal part of the decrease of the obliquity of the ecliptic than that generally assigned, which may have only a minor accessory share.

There is a well-known fluid the properties of which are in all respects suitable to the requirements, and that is quicksilver. Next after the very heaviest of solid substances it would naturally occupy this place; and the other materials of the terraqueous globe could be deposited upon it in successive layers. For the metals, silver, copper, lead, iron, and all the rocks, will *float* upon quicksilver; so that, in the constitution of the earth at its formation, a massive layer of it may reasonably be expected in this place. None but gold, platinum, and tungsten are heavy enough to sink in it: and even within reach of the earth's surface it is not always found in ore, but sometimes in its native fluid state among the rocks. It has been found useful and available in some electrical discoveries, and rotatory magnetic experiments.

An idea has been put forward by some, that the interior bodies in the earth undergo such an immense pressure from the superincumbent mass, that they are compressed into half or a third part of their bulk, and so weigh double or triple what they do at the surface; and this, no doubt, would be a fatal objection to Halley's theory. But it is put forward in ignorance or forgetfulness of the counterbalancing effect of the rotatory *centrifugal* force, and of other circumstances of the globular structure. If an arch were built a mile thick, would each brick of the inmost layer occupy less room and weigh more? Is the water of a trundled mop pressed to the centre?

In regard to the assumed position of quicksilver in mass lying deep down towards the centre of the earth, it need only be remarked that naturally the heaviest things fall to the bottom; but as it has been hastily treated as fanciful by an eminent mathematician, we must refer the reader to the exact calculations based on the weight of the whole collective globe compared with the rocks of the earth's surface and with water, which are given in a former work.[1] Quicksilver has also, of all substances, the greatest range of fluidity, very far beyond water, and the freest motion among its own particles.

IX. This deep-lying interior fluid, in which the solid nucleus of the earth is freely suspended, and has the axis of its rotation placed angularly to that of the earth, is acted on by the sun and moon with *tides* analogous to those of the ocean, which have been fully and incontrovertably demonstrated, with careful and judicious analysis of observed magnetic facts "of minute amount, but of extreme regularity," by the late General Sir Edward Sabine, corroborated by the late Astronomer Royal (though not referring to the interior *fluid cause*); who have each published in the Philosophical Transactions the results of their careful comparison and analysis of long series of these variations.[1] Two *lunar* tides occur in each lunar day; but owing to the immensely greater proportionate distance of the sun, there is only one *solar* tide daily, and also one *annual* solar tide when the earth is in the part of her orbit nearest to the sun.[2] The advance and receding of the magnetic *declination* twice in the lunar day, affords the best opportunity of judging of the particular nature and character of the moon's influence, as Sir Edward Sabine found. The cause of its assuming this tidal character is explained by Halley's theory, which thus derives from it a strong confirmation. Speaking of this lunar influence on the magnetic movement, the late Astronomer Royal says, "The inequalities are so evidently semi-diurnal that we may at once proceed to treat them on that assumption."

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[1] See the writer's appendix to part ii. of "Science and Geology in relation to the Universal Deluge," and other passages there.

X. We have often seen it stated, on the other hand, that Sir Isaac Newton and Laplace were both of them opposed to entertaining any thought of the earth's change of axis, as being apparently impossible owing to its prodigious weight and mass. Halley was the intimate personal friend of Sir Isaac Newton; but from his point of view it was far otherwise, on account of the internal constitution of the globe. A central nucleus, separated from the interior hollow of the solid globe by a fluid mass, in which it was free to move, though it had been at first rotating on the same axial line with the earth, would not, on a sudden change of the earth's axis, be at once moved from its position relatively to those points of the enclosing earth, to which its poles had been previously directed; but would tend to retain its position in that somewhat grooved hollow of the enclosing earth, to which its own oblate protuberance had from of old adapted itself, and would not change to the earth's new equator, but rather stick by the old. And, if the exterior mass of the globe suffered a sudden change of balance, that exterior mass would shift the plane of its rotation upon the nucleus, in the slippery fluid which separated them, towards that position to which the preponderating weight centrifugally impelled it. And as the two sides of the earth had been equally balanced one against the other upon the central nucleus, it was not the whole weight or mass of the collective globe which is to be considered, but only the excess of the one side and the relative defect of the other, arising from the cause of the change, whatever it was that had disturbed the balance. That might be a deposit of a considerable accession of matter from without falling upon some portion of the northern hemisphere, and perhaps occasionally marring the labours of husbandry with the curse of sterility,[1] or it might arise from the sudden sinking of a continent in the Pacific Ocean; which, by being thus brought nearer to the centre, would be diminished in its effect on the general central equipoise, on the well-known principle of the Steel Yard, by shortening its leverage.

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[1] Phil. Trans. 1847. And "On the diurnal variation at Toronto." Phil. Trans. 1856, p. 490.

[2] These facts have been fully stated in the author's previous work entitled "Physical Facts and Scriptural Record." 1872, p. 126.

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[1] Gen. v. 29.

If the occurrence of the former were *very gradual*, there would be time for the waters of the sea to readjust the balance; as the ocean may, and probably does, preserve the equilibrium, and prevent minor changes from affecting the axis of rotation. But that might only prepare the way, by the locally amassed weight of waters, for the sudden result. Halley saw and pointed out that the change of the axis of rotation required a fixed centre of the earth, on which the movement took place. The axis, of course, is not to be conceived of as if it were an inflexible rod passed through the globe, but only the line or diameter about which the free rotation adjusts itself to the true balance of the centrifugal force. It was not the mass of the earth which changed its position, but only the direction of the rotatory swing, which could not help changing from a false to the true balance of the movement.[1]

XI. Before proceeding to shew the bearing of these combined facts and views upon Dr. Hull's discovery of "another cause" of the supposed intense cold alleged to have frozen up, and covered, with ice thousands of feet thick, all the earth's best continents, we may be allowed briefly to notice one point more, which may not be irrelevant. It might naturally be expected that, in the first internal arrangement of the materials and deposits of the globe, under the operation of the constant centrifugal force in the diurnal rotation, alike in all the parallels of latitude, the tendency would be generally towards adopting, in the deposition of materials, an equatorial, and a polar position, or a position in parallelism with these. Yet we cannot but have remarked the concurrently oblique position of many of the countries, promontories, ridges, and gulfs of Europe and America, and of some of the mountain chains, tending towards a general direction from north-west to south-east. We find this largely exemplified in the peninsula of Italy, in Greece, in the Adriatic Sea, in the Red Sea, and the corresponding Egyptian coast line of mountains, and in the Persian Gulf; and again further West in the inclination of the British Islands, in the general lie of the American continents, particularly the isthmus of Panama, in the peninsulas of Florida and of California, ; in the coast of Labrador, and in the chain of the Rocky Mountains, that there is a distinct trend from the North-West to the South-East. The great chain of the Andes of South America may seem partly an exception among others, but it may be found that that chain is not so far from a direction perpendicular to what must have been the old equator, as to justify such a conclusion ; and mountain ranges are not of uniform arrangement, but may often be influenced by local causes. It has been remarked, however, that in the original strata of mountain ranges there is an extensive general parallelism, noticed by Baron Humboldt and the late Mr. Evan Hopkins, C.E., F.G.S., as inclining in a North-easterly and South-westerly direction.[1] But this original line is intersected by an electro-magnetic cleavage towards the North-West, to which Professor Sedgwick has called attention in the slate quarries of North Wales. His essay "On the Structure of large Mineral Masses" is referred to by Sir Charles Lyell with high commendation in his "Students' Manual" (1871). In the Welsh hills these cleavage planes are usually inclined at a very considerable angle to the planes of the strata. The average angle being as much as from 30° to 40°. The following remarks are extracted by Mr. Evan Hopkins in the words of Professor Sedgwick.

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[1] It must be observed that in any illustrative experiments made or attempted of the change of axis, *this* principle is prevented from being exemplified, by the strong attraction of the earth under the experiment drawing the over-weighted side down. But in the globe of the earth itself, this disturbing cause does not exist, there being no such external attraction beneath it.

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[1] Humboldt in his "Treatise on Rocks," as quoted by Mr.

"In that variety of slate which is used for roofing, the structure of the rock has been so modified that the traces of its original deposition are quite obliterated; and this remark does not apply merely to single quarries, but sometimes to whole mountains. . . . . . In the Welsh slate-rocks we see the cleavage planes preserving an almost geometrical parallelism, while they pass through contorted strata of hard slate, obviously of sedimentary origin. . . . . Crystalline forces have rearranged whole mountain masses of them, producing a beautiful crystalline cleavage, passing alike through all the strata. . . . . And again through all this region, whatever be the

Evan Hopkins in his work on "Geology and Magnetism," second edit., pages 34 and 35. From his own observation Mr. Hopkins states that on the Eastern coast of Ireland the cleavage planes of the gneiss and schist present a mean direction towards the North-East, and are intersected by more recent joints in a North-West direction, and that the same structural bearing is observed in North Wales and Scotland. Of the two lines mentioned the North-East is probably the old Polar, the other which is transverse to it the original line of the rotation prior to the change of axis. But this suggestion must be taken subject to more extensive future observations.

contortions of the rocks, the planes of cleavage pass on, generally without deviation, running in parallel lines from one end to the other, and inclining at a great angle to the West. . . . . Without considering the crystalline flakes along the planes of cleavage, which prove that crystalline action has modified the whole mass, we may affirm that no retreat of parts, no contraction in dimensions in passing to a solid state, can explain such phenomena as these. They appear to me only resolvable on the supposition that crystalline or *polar forces* acted on the whole mass in given directions, and with adequate power."

The polar forces here alluded to by Sedgwick may probably be forms of the electro-magnetic force, which is sufficiently penetrating and operative to answer the requirements. And the facts stated appear to show that that force had acted in a different angular direction.

From his extensive collection and personal observation of these classes of facts, Mr. Hopkins expresses a general deduction in these words: "Hence the crystalline crust of the earth is not a confused and shapeless mass of metamorphic and melted rocks, resulting from igneous eruptions, but possesses a structure and arrangement of parts, as regular and uniform as any other natural production." In other words, the stedfast law of cause and effect has been operating here as well as elsewhere. Is there anything here to favour the "Earth Movement" theory of alternate up and down "Vertical Oscillation"? We think not. Now we do not say that these facts would of themselves prove any change of the earth's axis of rotation; but we do say that when a change of the earth's axis is proved by a combination of facts, of reasoning, and of ancient and incontrovertible testimony, they may be found in agreement with it, and may thereby admit of explanation.

XII. We come now to the point at which the collective facts, as well as the clear testimonies of antiquity, have a distinct bearing upon Dr. Hull's espoused theory of the continent of America having at one time been raised aloft into the air, ten or twelve thousand feet above the sea-level. With regard to its supposed alternate up-heavings and down-lettings we need not concern ourselves; the facts alleged show nothing but a sinking. Let us see then whether the change of the earth's axis of rotation, which explains so many things, will also explain this *sinking* of the relative level of the American continent. This may be best done by the help of a simple diagram, such as the annexed.

In proceeding to apply this diagram it should be distinctly kept in view that the change of axis consisted, as above pointed out, simply in the shifting of the axial line of the earth's rotation, from M to N in the North, and from M′ to S in the South. It was not the heavy mass of the earth which moved, but the mathematical line of its rotation which adjusted itself at right angles to the direction of the preponderating centrifugal force.

It will at once be seen that by the change of the earth's axis of rotation to N, M, which previously was at the North Pole of both the earth and the Nucleus, has become 18½ degrees distant on the meridian from the pole; and A, which originally was 18½° distant from the Pole, now has its distance on

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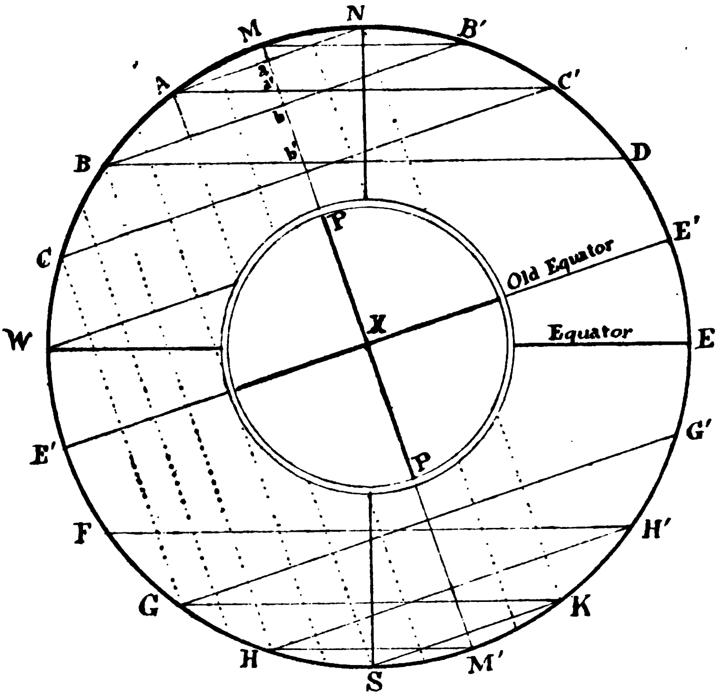

Diagram to illustrate the effects of the change of Axis in causing the submersion of certain Lands.

the arc of the meridian doubled. In like manner B, which was originally 37° distant from the pole, now has its distance on the meridian changed to 55½°. The direct distance of each of these points, A and B, from the original axial line of rotation MM′, is increased on the new parallels. The necessary consequence must be that whatever land was just above the sea-level at these points respectively, is now dipped under the sea; as will appear from hence.

Let Aa be the perpendicular distance from A to the old axis, and let Aa′ be the distance of A from the intersection of the old line of axis with the diameter of the *new* parallel of rotation AC. We have then a triangle Aaa′, right-angled at a. Similarly let Bb be the perpendicular distance of B from the old axis of rotation, and Bb′ its distance from the intersection of the old axis of rotation with the diameter of the *new* parallel of rotation BD. Then, as in the triangle Aaa′ right-angled at a, the hypotenuse Aa′ is greater than Aa, the original distance, so here in the triangle Bbb′, the hypotenuse Bb′ is greater than Bb, which was the old distance. The old distance, therefore, in each of the cases, was insufficient to reach to the surface of the new sea-level on the changed rotation. This is simply owing to the larger circle and greater diameter of the *new* parallel of latitude in comparison with the *old*, at the same point, A; or, in the other triangle, at the corresponding point B. Yet A and B are each of them precisely where they were upon the globe, without a vestige of Dr. Hull's assumed alternate dynamical see-saw of Vertically up and Vertically down; or as he expresses it, "Vertical Oscillation," assumed to be on a mountainous scale.

Not much heat was to be gained by the deepest cold bath, any more than so much intense refrigeration by the original altitude, whatever it may be assumed to have been. About that it is needless to differ. Whether A or B originally held its head six hundred feet above the sea, or whether 2700 or 3000 feet, or even if the upper of the two sub-oceanic shelves had never at all been a sea-beach or shore, but had been mounted originally a thousand feet higher, illustrating the American rivers with magnificent cascades, still it will be found on calculation that the cases will possibly allow for all that, or even more; and yet A and B are just in their old places, and at their original distances from the old axis of rotation, and at their unaltered original elevation in relation to the *solid mass* of the earth. Only it is the sea which has sought and taken its own natural level, in relation to the altered axis of the earth, and of all its meridians and parallels of latitude. It may be thought a pity that there should be no occasion left for the invention of some new geological dynamics for upheaving the vast continent cf America from time to time, and from time to time letting it down again, to suit new-born theories, and do away with an old-world Deluge, though that explained all the facts much better.

But, in regard to these remarks, it must be observed that on the *South-West* of the old equator there would be a difference; and also the principles do not apply in the same manner to the opposite quadrant on the *North-Eastern* side of the world.

The effect on the *South-Eastern* quadrant again would correspond to that on the North-Western, which we have been illustrating in its sinking. The reader may at once perceive this for himself, on considering the diagram, and applying the same principles. On the alternate quadrants the case would generally be *reversed.* Instead of sinking, there would be raising; and *vice versâ.* The difference of effect in the respective cases is simply owing to the old and new axes of rotation having crossed one another at the centre; so that when the old axis, which was at M M′, removed to the new position N S, the axial change from M to N would be contrary to the movement of the other end of it from M′ to S; and this would affect the measures and distances of points in a contrary manner in the two quadrants N W, and N E. The same would happen in regard to the two southern quadrants S W, and S E; the southern quadrant, S W, being also affected in the contrary way to N W. The argument of Professor Hull in the paper immediately before us, accordingly does not touch any part of South America, but is confined to the two sides of the *North* Atlantic; and, more especially on the American side, not reaching further South than what he calls "the Antillæan Continent," that is, the land now underlying the West Indian Islands. But in his later paper, read on the 19th of February last, he followed up his subject to "the Sub-Oceanic River Valleys of the West African Continent, and of the Mediterranean Basin." The West African Continent numbers a variety of well known rivers, the Niger, the Senegal, the Gambia, the Congo, and the Orange; but from none of these rivers has Dr. Hull been able to find any proof of what he calls his "Vertical Oscillation" (that is, his theory of the land having been alternately heaved vertically a few thousand feet up, and then dipped vertically down under the ocean, an equal quantity), except only from the river Congo, as to which two other geologists appear to have preceded him. But as the Congo is not entitled alone to speak for all its brother rivers, and for a whole continent and a whole ocean, the probability therefore of the bed of the ocean having at some former time been actually raised to the extent indicated of 2000 fathoms (=12,000 feet) or upwards, may be dismissed for the present.[1]

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[1] Dr. Hull in his paper of the present year writes: "Where the descent into the Abyssal region, down to say 2,000 fathoms and upwards, is rapid or almost continuous, as is the coast of Ashanti, it is difficult or impossible to define the level of the old coast during the period of maximum elevation, because we are confronted with the question, *Was the bed of the ocean actually raised to the extent here indicated by the base of the escarpment?* . . . . We cannot answer this question." But why raise questions which cannot be answered? He shows us, however, what he means by the phrase "Vertical Oscillation." It is vertical movements both of elevation and depression alternating, to the height and depth of 2,000 fathoms, or 12,000 feet.

But on coming to the Submerged Valley of the Congo, Dr. Hull remarks, "In dealing with this subject I feel that an apology is needed. . . . I might well have brought my own investigations regarding the sub-oceanic river valleys of the Eastern side of the Atlantic to a close on reaching the Straits of Gibraltar." This is modestly put, and we are inclined to agree with it.

It may be remarked in passing, on a slight point of diction, that Dr. Hull now writes "*abyssal*," though in his former paper he more correctly and euphoniously wrote the word "abysmal," which is justified by the authority of a correct and eloquent writer, and by the example of the French *abisme* now usually circumflexed, *abime*. In the *adjective* the *m* is indispensable for euphony. Dr. Hull will pardon me, in this slight matter, for upholding his first usage.

XIII. It is in harmony with those principles which we have been endeavouring to illustrate, that, in contrast to the North-Western submergence, there is in the North-Eastern parts an immense Elevated Table Land in Eastern Asia, extending as we are informed,[1] near the parallel of 50° N. Lat., all between 82° and 120° East Longitude; and at 40° N. Lat., from 72° East Longitude reaching due southward to 34° N. Lat.: from which it follows the range of the Himalaia Mountains to 82° East Longitude, when this chain, which constitutes the south edge of the Table Land, begins to turn nearly due East, and continues in that direction as far as 90° East Longitude, near the parallel of 28° N. Lat. Thence it passes S.E. to the Table Land of Yu-Nan, near 25° N. Lat. and 103° East Longitude, which forms the most Easterly point of the main Table Land of Eastern Asia. The Eastward Boundary runs along the range of the Yun-ling Mountains in a N.N.E. direction to the most northerly bend of the river Hoang-ho 41° N. Lat., 109° East Longitude. Here the Yung-ling ridge is parted only by a narrow valley of the river from the In-shan Mountain range, which now forms the boundary, running Eastward to 116° East Longitude; and thence to the North boundary of the Table Land between 51° and 52° N. Lat., and 121° East Longitude. The whole of the immense area within these lines is of considerable elevation, increasing towards the south; only a few small tracts of country being supposed to have less than 3,000 feet above the sea level, and many of the southern plains rising to 10,000 feet. There are probably above two hundred summits which rise to more than 18,000 feet; and there is one of 26,862 feet high, another of scarcely less altitude, and one of 25,749 feet. From the Eastern boundary, the land seems gradually to decline towards the East.

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[1] We take this statement, slightly compressed, from MacCulloch's Dictionary Geographical, Statistical, and Historical, vol. i. p. 167, and following.

On the other hand in the *South-Eastern* Quadrant, the submersion of lands which were once united is conspicuous. Witness Southern Siam, the Malay Peninsula and Archipelago, Sumatra, Borneo, Java, and the Philippine Islands, all South of the old equator and for the last of which Lyell says, a more elevated level of a hundred fathoms would suffice; and perhaps Ceylon with the Laccadive Coral Islands, if the latter indicate a chain of sunk mountain tops, which were also all of them South of the old equator, together with probably other portions of land which have disappeared beneath the waters. On the other hand the island of Celebes is shown by its native animals, which are marsupial, to have been originally adjoined to the Australian group.

In regard to the South-Western Quadrant, the enormous mass and extreme altitude of the mountain chain of the Andes and Cordilleras, stretching the whole length of South America, and dividing into several branches, supported also by other chains in the Eastern side. The Andes and their ramifications have been roughly estimated to cover in Peru alone an extent of two hundred thousand square miles, enclosing many extensive and lofty valleys round Cuzco in a vast knot of mountains covering about three times the space of Switzerland: and round

Pasco in Lat. 13° S., is another knot surrounding the plain of Bonbon 13,500 above the level of the sea. The loftiest mountains are towards the South. The coast is throughout rugged and lofty. I may mention in connection with these extremely lofty districts that the old equator appears to have passed through them, lying from near *Natal* at Cape S. Roque, past Serro de Pasco, to a little South of Cusco. In Bolivia the Andes of the knot of Porco may be considered as the central portion and have an altitude of from 15,913 and 16,037 to 21,000, and 22,000 feet, and extend in length from lat. 14° S., to lat. 20° S. and in breadth, at the North 200 miles, at the South 250 miles. Apart quite from the Andes, and on the Eastern side, the extensive empire of Brazil is said to consist, two-thirds of it of high lands and mountains; and, including the Pampas and other vast plains, I find the *average* elevation of South America, stated at 2000 feet. This certainly does not show sinking. I find it also stated by Sir Charles Lyell, that "The continent of South America, from lat. 34° S. to Patagonia, appears also to have been upraised throughout its entire width, since the beginning of the Post-tertiary period."[1]

Returning to our North-Western Quadrant with which we have been principally concerned, we have already pointed out that our diagram shows ample room for the sinking of the North American coast to have amounted to 600 feet, or to 3000 feet, or perhaps more. If it were with empty space that our reasoning had to deal, our diagram would afford means of more accurate determination, by calculation based on the right angled triangles, for their measures are all determinable from known data. But in dealing with the solid globe, the materials of which must have been subjected, in the sudden change of the rotation, to considerable strain and disturbance, and to much friction developing heat, with fusion and eruption of basalt, as well as much violent superficial drifting, we are not in possession of sufficient information of how the interior constitution of the earth was affected, to furnish data for any approach to accuracy of conclusion. This only I may venture to say, that there is no ground for doubting that the shifting of the Eastern coast line of America may have amounted to as much as would satisfy all reasonable demands. Dr. Hall's Paper has, I am persuaded, done some service to the truth, but not at all as he wished or expected.

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[1] Principles of Geology, vol. i. p. 250, 10th edit., 1867.

XIV. All the known facts of geology, which have any bearing on the period, give confirmation to the above view. The tremendous rush of the Northern seas hurrying from the pole, bearing along with them icebergs and vast fields of thick ice, with rocks snapped off, and other deposits, sweeping along also a sediment of dense mud, clay, and boulders, with shells of the sea bottom, trees and fruits of the land; grooving and striating the rocks, and, from their swollen and miles-deep accumulation of moving waters, stranding fields of massive ice on hill tops, or in high valleys, or on mountain slopes, gradually to sink, and shape themselves into the valleys as future glaciers, with deep occasional splits and crevasses formed in the process; others, at the same time, breaking off rocks and scattering them as boulders, some carried far upon their ice-floats and deposited, as these toppled over, upon plain or hill; more abundantly in Northern parts, more sparingly in Southern after the most numerous and the biggest had been already dropped. And in this torrential and appalling progress there were swept along also huge animals, mammoths, rhinoceroses, hippopotami, all to be dashed to pieces and deposited in fragments, here a massive tusk, there an elephant's tooth, in another place the fractured jaw of an ox, or the head of a hippopotamus, mixed up with teeth of a lion or hyena; the animals not found whole but all fragmentary, scattered, and separately deposited in bits, or in unconnected groups of horns and bones of dismembered beasts, illustrating the absolutely tremendous, as well as sudden, nature of the world-wide catastrophe, and the appalling force and violent rapidity of the drift, of which the evidences are spread in many lands. But where the freezing northern ocean rolled in unpolluted with earthy admixture, a whole elephant, or other of the hugest animals, might be suddenly engulfed and frozen up whole in solid ice, to last for ages, and to furnish food for wild dogs within recent memory. Fields of clear and solid ice were also stranded upon the lower lands of Siberia, and being lashed over with a deep covering of earthy or mixed deposit, not destitute of diluvial remains, became left to the boring and discovery of travellers in long subsequent ages, even within this still living generation. Caves, once perhaps the resort of tigers or hyenas, were silted up with miscellaneous drift of shells, teeth, and shattered and splintered bones to be slowly covered up with stalagma, and overhung with stalactites from the dripping of waters through the soaked overlying strata; skeletons of mice and other small animals washed in even whole amid the clay and mud; while quantities of the smaller and less destructible portions of animal remains, such as teeth and light fragments of bones, were lashed about by the waves, and washed into crevices and spaces of the rocks, to form a hard and compact breccia, as at Gibraltar. Spitzbergen, Nova Zembla, Iceland, and the arctic shores of Siberia, as well as the British Isles, bearing proofs of having formerly had a warmer or more temperate climate than they now enjoy—all of these things bear testimony to the Universal Deluge, and to the nature and physical cause of it; which, we have seen, the Word of God, as well as the revelations of nature, attests to have been a change of the earth's axis of rotation. Truly the plain evidences of the fact are more awful than imagination could have conceived. "Thus and not otherwise," as Halley two hundred years ago declared, "may we explain the changes of the variation of the magnetic needle." Thus and not otherwise, it may now be added, may we satisfactorily explain the discoveries of Cuvier, and of the earlier and sounder geologists of the present century, and of scientific explorers in many regions of the earth; not omitting such men as Murchison, Sedgwick, and Buckland, the last of whom in his *Reliquiæ Diluvianæ* has gathered a testimony never to be despised or put aside: though Dr. Hull but lately expressed himself startled, "to have Dr. Buckland's *Reliquiæ Diluvianæ* unearthed from its tomb, and brought up again 'in this year 1894' by so eminent an authority as Professor Prestwich."[1] But the truth is not dead or buried yet, nor even submerged, either to "the abysmal depths," or to "the hundred fathom line of the ocean."

XV. The extreme violence of the rush of the deep volume of waters, and the drift which they bore along with them, especially in the Polar and Northern regions, which is spoken of by the Psalmist[2] as having caused them to "*go up the mountains*," just as the waters of a streamlet rise to pass over an opposing stone, was plainly a necessary result of the change of the axis of the earth's rotation. For, at the old Pole, the waters which were there had no diurnal rotation, but were at rest as on a pivot, simply turning round once in twenty-four hours; but when removed 18½° from the Pole, their new position had the rate of rotation of the parallel of latitude of 71½°. I find on referring to a table of the number of miles in each degree of longitude, that in that parallel of latitude there are about 21·89 English miles; so that, in the 360° of the circle, the measure round would be 7880·4 miles, and the rotation of this is daily accomplished in twenty-four hours. The rate of revolution is therefore 328·3 miles an hour. But the waters which had been at rest at the pole, would not suddenly adapt themselves to this new velocity, but would be overpassed by it, and falling behind, would produce the equivalent of a strong current in the contrary direction. On the other hand, the waters which had formerly been 18½° from the pole, and which had been rotating with the globe at the velocity of that parallel of latitude, would not lose their impetus to proceed at the same rate when brought up to the pole which is at rest, but would rush on with that enormous velocity, away from the pole and to the South-Eastward spirally round the world, and at the opposite side of the world would meet in conflict with the other Westerly current already mentioned. Nor would this cause of conflicting opposite currents stop there, but would go on in a diminishing rate at every changing parallel of latitude Southward, until they adjusted themselves to the altered position. But at places on either the old or the new equatorial line, the maximum difference of the velocity of rotation produced would be about 54 miles an hour, somewhat under the speed of an express train! And at those two places where the old and new equator crossed one another, there would be no change of rate; and at each side only a gradual increase of it as the places were further remote in their position on either line. Passing from the extreme North into the temperate zone, the extreme violence would gradually abate, and the force become broken or diminished by the succession of opposing mountain ranges; within the encircling enclosure of which, though all were overtopped, the ark might float in comparative quiet and safety, say within 40° North latitude, which is 50° distant from the Pole.[1]

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[1] Journal of the Victoria Institute, vol. xxvii., p. 292.

[2] Ps. civ. 6—9. Septuagint (ciii.) ver. 8, Ἀναβαίνουσιν ὄρη καταβαίνουσι πεδία.

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[1] See this and various other points more fully illustrated in

XVI. One further remark it may be proper not to omit. It is manifest, as has been already pointed out, that at two points of the earth's surface, where the former and the present equator crossed each other, and in some adjacent parts, there would be no sufficient change in the local rate of the rotation to affect the waters there with equal violence, and therefore comparatively less submergence of the land, insufficient to cover its high hills or mountains. These, therefore, would in the equatorial regions, at that time uninhabitable by man, afford a refuge for the tropical wild beasts, lions, tigers, leopards, hyenas, gorillas, rhinoceroses, naked (not woolly) elephants, kangaroos, emus, boas, cobras, rattlesnakes, vipers, scorpions, and all the rest, an innumerable multitude not included in the Noahic list of clean and unclean animals, and which accordingly were not, any of them, with Noah in the ark (Levit. xi.; Deut. xiv. 4—20; Gen. vii.). The late Bishop Harold Browne has called our attention to the fact that, in the record in the book of Genesis, animals are mentioned which survived the Deluge, and yet were not in the ark: since God established his covenant, not only with Noah and his seed, but extended it with them to every beast of the earth, "from all that go out of the ark, to every beast of the field." Many unnecessarily imagined difficulties are thus swept away by the simple biblical narrative.[1]

my work entitled "Physical Facts and Scriptural Record," Proposition xviii., p. 196, and onwards to the close.

[1] The Speaker's Commentary, Gen. ix. 10.

APPENDIX.

ON THE DIFFERING MAGNETIC PHENOMENA OF THE SOUTHERN HEMISPHERE.

We are looking forward now with much interest to the projected Antarctic Polar Exploration, and its expected scientific results. The difference of the Southern magnetic phenomena from correspondence with those of our Northern hemisphere, still awaits its explantion. To avoid prejudiced conclusions, observe,—

I. On Halley's theory, the axis and poles of the earth's rotation are not to be assumed as quite the same with those of its spheroidal figure. For the *change* of axis was a re-adjustment of the rotation to the true balance of weights, which had departed from the former proportions of external measurement. The axis of rotation passes through the centre of *weight*, which is by no means necessarily the centre of form and measurement.

II. The rotation of the nucleus upon its axis may not be in such wise the determiner of the Southern magnetic effects, that these should be referred exclusively to its South pole, and be expected to show the same convergence as in the North. And the internal constitution of the nucleus as well as of the earth, may be far from being of equably distributed magnetism. Of two of the few heaviest materials which we naturally refer to the nucleus as forming part of its solid spheroid, *platinum* is classed by Faraday as a paramagnetic substance;

that is, tending to arrange itself in a polar manner like iron: but *gold* on the other hand, and *mercury* along with it, are found by Faraday to be *dia*-magnetic, tending to a transverse or equatorial position. We do not know whether these differing qualities, may have partly directed the position assigned to them when at first deposited. But in regard to the transmission of the magnetic rays to the earth's surface, we may have to make allowance for some effect of the materials through which they pass. A predominance of gold may affect it differently from a predominance of iron; and it by no means appears that these are disseminated everywhere in the same proportions. Australia and South Africa seem to claim a preponderance of gold. One thing at least is stated concerning effects: the magnetic direction of the needle is affected in passing from sea to land.[1] Water has been shewn by Faraday to be *dia*-magnetic; placed between two powerful magnets, it arranged itself *equatorially* not *axially*, and this to such an extent, that by artificially strengthening the dia-magnetic force, it has been proved equal to deflect the needle.[2] Where therefore, there is a continuous uninterrupted ocean in the Southern regions all round the world, may not some deflection of the needle be expected from this cause? Action and reaction are equal. Is then the little slender needle to deflect the ocean, or the vast uninterrupted ocean the little needle? A boatman pushes away the land, but it is the boat which goes.

III. Some years ago the writer took the pains to compare with one another some observations of the magnetic declination, taken in the Antarctic voyage of the late Sir James Ross. The first of those examined had been taken in lat. 64° 24′ S., and long. 148° 27′

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[1] Humbolt, *Cosmos*, vol i. p. 174. Bohn's Edit.

[2] Experiment by the late Prof. Tyndall. Phil. Trans. vol. cxlvi. for 1856, p. 251.

E.: the second in lat. 65° 4′ S., long. 142° 49′ E. In the first the Needle pointed 10° 41′ East of South: in the second the declination was 12° 37′ E. Now rectifying the globe for each of these cases in turn, by elevating the South Pole above the South point of the horizon to the degree of the given latitude, and bringing the given longitude in each case to the zenith, fixing the quadrant of altitude over it there, and conducting the graduated edge of the quadrant the number of degrees of azimuth (measured from the south point of the horizon) corresponding to the observed magnetic Declination,[1] the results obtained were extremely at variance with what would have been expected if in antipodal position to the North Magnetic Pole. But on drawing on the globe each of the lines indicated by the Needle, in the two observations, a remarkable circumstance appeared: the lines were *parallel* to each other, not converging at all. And this circumstance of itself would seem to indicate that these two lines are not lines conducting to the Magnetic South Pole; otherwise in that high latitude they must have shewn some convergence: but they are more likely in this instance *parallels* obliquely transverse. Other examples were taken from the observations made in the same Antarctic Expedition. Thus between November 1840 and April 1841 on board H.M.S. Terror, in lat. 54° 5′ S., long. 134° 44′ E., the declination was

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[1] The effect of the described adjustment of the globe is, that the place of the magnetic observation, defined by its own given latitude and longitude, is brought to the zenith, so as to make the graduated horizon of the globe answer for the horizon of the place of observation, having the graduation and points of the compass the same, and shewing, by the degrees which are cut by the edge of the affixed quadrant, in measured distance from the South point Eastward or Westward, the direction of the recorded declination of the magnetic needle at the given place. So that in each case, by this process, all the different observations of the magnetic declination, and their lines of direction, are successively brought into comparison, as it were, in one mariner's compass.

3° 1′. On similarly rectifying the globe, and drawing the line of direction found by the quadrant, as before, it was nearly parallel to the two last mentioned. On board the same ship in lat. 55° 5′ S., long., 123° 7′ F., the declination was 0° 59′ W. On applying the same method this line of direction was found not only *not convergent*, but slightly *divergent* from the three preceding. In the same ship in lat. 56° 39′ S., long. 129° 45′ E., the declination was 6° 13′ W.; a direction which, on the same mode of trial, is found *more* divergent. On board H. M. Ship Erebus, on the same voyage, in lat. 56° 14′, long. 130° 44′ E., the declination was 5° 17′ W. giving a line of direction *nearly parallel* to the lat. In the higher latitudes the divergence becomes even more conspicuous, nay extreme. Thus on board the Erebus, in lat. 76° 23′ S., long. 177° 25′ E., the declination was 84° 55′ E.; and on board the same ship in lat. 77° 52′, long. 189° 27′ E., the declination was 93° 38′ E., giving lines of direction diverging from one another on the globe, and greatly diverging from the others above specified.[1] A number of other cases were examined by the writer with similar results.

In the attention given by philosophers to the convergence of the *Isogonic* lines, the fact to which we have been adverting, namely, the *absence* of convergence, and existence of divergence, in the lines of direction in the South, seems generally to have escaped notice. To the present writer it seems important, if a true explanation of the Southern magnetic phenomena is sought; and his detailed examination of the facts, as above referred to, appeared to him to shew that in the Southern hemisphere, and particularly in marine observations, there is indication of a large, if not sometimes predominant, influence of dia-magnetic or equatorial force. Of course this simple method by the globe does not pretend to ensure perfect accuracy; but *that* is assumed to be given in the recorded observations, and all that is attempted is a reasonably fair comparison of their respective results and general bearing. The above statements admit of being tested; and, if approximately correct, they appear to shew that the polar magnetic needle had been much deflected by some dia-magnetic force. For by the substituting of parallel lines for convergent, the distance of the pole might probably be overshot; and by divergent lines it would be changed in direction; and a false position of it would thus be obtained. It need only further be remarked that, on Halley's theory, the difficulty may be diminished, and solution made more hopeful; because there is more room for difference of effect, when the magnetic force comes apportioned between the earth, and the differently revolving and differently constituted nucleus.

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[1] The last six observations cited are taken from the Philosophical Transactions for 1868, from the tables there given of the results of the Magnetic Survey of the South Polar Regions, with General Sir Edward Sabine's review of them, p. 389 &c. See also the writer's "Physical Facts and Scriptural Record." Rivingtons, 1872. Pages 108—159—189.

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